New Hampshire Residential Solar Photovoltaic (PV) Structural Review Worksheet

Usage Guide for the Structural Review Worksheet

Disclaimer: *This sample worksheet is for informational purposes only and may not be used to satisfy municipal permitting or review requirements unless customized and expressly adopted for such use by the permitting municipality. The State of New Hampshire, the authors of this sample worksheet, and other organizations and individuals who contributed to this sample worksheet assume no responsibility for the use or misuse of the information contained in this sample worksheet and expressly disclaim liability for any damage, injury, loss, or expense arising from the use or misuse of the information contained in this sample worksheet. Use of this sample worksheet does not exempt the user from their responsibility to ensure compliance with all applicable municipal, state and federal laws and regulations.*

This Structural Review Worksheet can be used to evaluate the integrity of a roof's framing for a proposed solar PV system. It is not for use in qualifying the adequacy of the attachment of the PV panel system to the roof structure for code-required design loads. To use this Worksheet in an official capacity, you will need permission from the municipal building department. It is not intended to serve as a permit application but could be used as part of a permit application at the jurisdiction's discretion.

The Worksheet identifies structural conditions in a home's roof framing that may raise concerns with the installation of solar PV, including increased dead load and wind uplift.

This worksheet only applies to installations that meet the following basic criteria, as well as the more detailed criteria below and elsewhere in the Worksheet:

• Installation on one or two family home built after 1930

• Installation on home with conventional wood light-frame construction (commonly referred to as "stick-built" framing).

• Installation on home with asphalt shingles. Homes with metal roofs are excluded.

• Solar PV panels are flush mounted (i.e., installed parallel to the roof)

User Qualifications for the Structural Review Worksheet

Users of this worksheet should have demonstrable knowledge of typical residential roof framing systems. A licensed design professional or a number of certification programs may be acceptable evidence of qualifications, if approved by the local jurisdiction, for example:

- Registered Design Professional (Professional Engineer or Architect)
- Licensed Home Inspector
- Engineer-in-Training (EIT)
- North American Board of Certified Energy Practitioners (NABCEP) PV Installation Professional certification
- Other approved certifications that require training in structural inspection of residential framing systems.

Visibility Requirements:

Worksheet users must be able to view the roof framing to evaluate its strength. Enough of the framing must be exposed to be able to determine at a minimum:

- Rafter size and spacing
- Ridge board versus ridge beam
- Configuration and continuity of ceiling joists, rafter ties, and/or collar ties, including size, spacing, and splice details.
- Existence of framing irregularities (e.g. skylights, dormers) in the vicinity of the proposed PV panels
- Type of roof sheathing (e.g. plywood, oriented strand board (OSB), straight board sheathing)

If the framing is concealed by finishes, such as in spaces with cathedral ceilings, a Registered Design Professional should investigate the framing and review the proposed installation. Openings may be required in the finishes to observe the framing and document the construction details listed above.

Anchorage to Structure

Use of this worksheet is contingent upon fastening the PV system directly to the rafters. If the installer wishes to attach to the sheathing between the rafters, a registered design professional should evaluate the proposed design and confirm the available sheathing capacity. If the sheathing alone is not adequate to resist downward gravity, wind uplift, or component anchorage forces, the addition of blocking between the rafters at the attachment locations may be a possible solution.

Project Information

(This project information sheet compiles general information about the proposed PV array installation that may be useful whether or not the project qualifies for use of the structural evaluation and span tables on the following pages. It may be used as a standalone supplemental form or in conjunction with the Structural Evaluation portion of this Worksheet on the following pages, 3-4)

Please fill in the following Project Description information

PROJECT DESCRIPTION:

Ground Snow Load[1]: Basic Wind Speed: Wind Exposure Category[2]: ☐A ☐B ☐C ☐D

Roofing Type and Age: Enter Text Number of Layers of Roofing: Enter Text

(e.g. asphalt shingle, slate, clay tile, cedar shake, metal seam, single-ply membrane, built-up)

Age of roof structure: Enter Text

Roof Type (e.g. gable, hipped, shed, flat): Enter Text Roof pitch: Enter Text

Framing Type (e.g. rafters, trusses): Enter TextIf trusses, list manufacturer, if known[3]:

For standing seam roof, confirm compatibility of clamps and roofing system ☐Yes ☐No

Rafter Material (wood, steel, etc.; if wood, specify rafter species and lumber grade[4]): Enter Text

Nominal Rafter Size (e.g. 2x6): Enter Text Rafter Spacing (e.g. 16"): Enter Text

Rafters Marked with Grade Stamp? ☒Yes ☐No Finish Ceiling Attached to Rafters? ☐Yes ☐No

Maximum unsupported rafter span, measured horizontally: Enter Text Feet Enter Text Inches

Ceiling joist or rafter tie size and spacing (e.g. 2x6@16"): Enter Text

Ceiling joist or rafter tie orientation (relative to rafters): ☐parallel ☐ perpendicular

Height of ceiling joist or rafter tie measured vertically above top of rafter support walls (enter "0" if ceiling joists are located at the top of the support walls): Enter Text

Height of roof ridge measured vertically above top of rafter support walls: Enter Text

Ridge type (ridge beam supported by posts or ridge board): Enter Text

Framing Irregularities in vicinity of proposed panel installation (e.g. modifications, skylights, dormers, valleys that interrupt rafter spans): Enter Text

Heavy equipment or unusual loads suspended from rafters in the vicinity of proposed panel installation: Enter Text

Other information/Comments: Enter Text

1 Municipalities must use the town- and elevation-specific data in the following report to determine the ground snow load: http://www.senh.org/wp-content/uploads/2010/12/tr02-6.pdf. Installers must confirm the applicable ground snow load with the local code official.

2 http://publicecodes.cyberregs.com/icod/irc/2009/icod_irc_2009_3_par010.htm

3 If the home has roof trusses, a truss report should be submitted detailing their load capacity.

4 Obtain species from grade stamps on the rafters. If no grade stamps, assume Spruce-Pine-Fir #2.

Please Perform the Following Roof Load Calculations

ROOF LOAD CALCULATIONS:

a. Total weight of PV modules, rails, mountings, hardware and wiring	Enter Number Here Lbs.
b. Total number of attachments (mountings)	Enter Number Here Mountings
c. Weight per attachment point (mounting) a÷b	Enter Number Here Lbs. /Attachment
d. Maximum spacing between adjacent attachment (mounting) points	Enter Number Here Feet-Inches
e. Total surface area of PV modules (square feet)	Enter Number Here Ft^2
f. Distributed weight of PV modules a÷e	Enter Number Here psf

Structural Evaluation

Please answer the questions in the Maximum Rafter Span Table Qualifier

Maximum Rafter Span Table Qualifier

1)	Was the house built after 1930?	☐Yes	☐No
2)	Does the roof have asphalt-shingle roofing with no more than one layer?	☐Yes	☐No
3)	Does the roof have a slope of 4:12 or greater?	☐Yes	☐No
4)	Is roof framing conventional wood light-frame construction (not trusses)?	☐Yes	☐No
5)	Is the rafter spacing 24" oc or less?	☐Yes	☐No
6)	Are the rafters fully exposed with no finishes attached and no plans to add finishes?	☐Yes	☐No
7)	Are rafters directly fastened to ceiling joists located at the top of the supporting walls to form a continuous tie from one supporting wall to the other, noting that the ceiling framing must match the rafter spacing and direction?	☐Yes	☐No
8)	Is the framing in the vicinity of the solar array free of irregularities (see Roof Description for examples)?	☐Yes	☐No
9)	Is the framing in the vicinity of the solar array free of heavy equipment or unusual loads?	☐Yes	☐No
10)	Is the roof framing free of visible indications of distress (e.g. ridge sagging, walls out of plumb, significant ceiling cracks, split rafters)?	☐Yes	☐No
11)	Is the roof framing free of signs or knowledge of previous damage (e.g. water incursion, fire damage, impact from an object, insect damage, etc.)?	☐Yes	☐No
12)	Is the new PV system flush mounted, with a maximum angle of 5 degrees steeper than the roof slope and a maximum gap of 6" between the roof surface and the solar panels?	☐Yes	☐No
13)	Is the "distributed weight of PV modules" less than or equal to 4 psf (see "Roof Load Calculations" p. 2)?	☐Yes	☐No
14)	Is the weight of finish roofing materials, roof sheathing, roof framing, and other materials (not including PV panels) that are attached to rafters less than or equal to 10 psf?	☐Yes	☐No
15)	Is the Ground Snow Load at the site 70 psf or less?	☐Yes	☐No
16)	Is the "weight per attachment point," based on system weight only, less than 45 lbs. (see "Roof Load Calculations" p. 2)?	☐Yes	☐No
17)	Is the attachment point of the PV system support frame fastened directly to the rafters, and not solely to the sheathing between the rafters?	☐Yes	☐No
18)	Does the PV support frame distribute the weight of the array evenly to every rafter, and load each rafter along its length no more than 24 inches apart?	☐Yes	☐No

If <u>all</u> answers are "Yes," proceed to Rafter Span Verification. If any answer is "No," enter "NA" for your answer to Question 19 on the next page and employ a Registered Design Professional to evaluate the roof structure.

Structural Evaluation

RAFTER SPAN VERIFICATION

Refer to the Rafter Span Tables on pages 5 and 6 to determine whether the "Maximum Unsupported Span" (provided in the "Roof Description" on page 2) is less than the maximum allowed rafter span. *(Consider wood species, rafter size, and rafter spacing in your assessment.)*

19) According to the Rafter Span Table, is the observed "Maximum Unsupported Span" less than the "Maximum Rafter Span" listed in the applicable table? ☐Yes ☐No ☐N/A

STRUCTURAL REVIEW WORKSHEET CONCLUSION:

If your answer to Question 19 is "Yes," you do not need to employ a Registered Design Professional to evaluate the roof structure unless required to do so by the local jurisdiction.

If your answer is "No" or "N/A," the home may still be able to support a PV array, but the installation requires the review of a Registered Design Professional and roof strengthening may be needed.

New Hampshire Residential Solar Photovoltaic (PV) Structural Review Worksheet
PAGE 5 OF 5

MAXIMUM RAFTER SPANS FOR ELEVATION-ADJUSTED 50, 60, AND 70 PSF GROUND SNOW LOADS[1]
Maximum Dead Load Including PV Panels = 14 psf
Ceiling not attached to rafters (deflection ≤ L/180)

Elevation-Adjusted Ground Snow Load = 50 psf		Rafter Size				
		2x4	2x6	2x8	2x10	2x12
Rafter Spacing	Species and Grade	Maximum Rafter Spans (ft-in)				
12″	Spruce-Pine-Fir #2	7'-0"	10'-3"	13'-0"	15'-10"	18'-5"
	Douglas Fir-Larch #2	7'-4"	10'-9"	13'-7"	16'-7"	19'-3"
	Hem-Fir #2	7'-4"	10'-9"	13'-7"	16'-7"	19'-3"
16″	Spruce-Pine-Fir #2	6'-1"	8'-10"	11'-3"	13'-9"	15'-11"
	Douglas Fir-Larch #2	6'-4"	9'-4"	11'-9"	14'-5"	16'-8"
	Hem-Fir #2	6'-4"	9'-4"	11'-9"	14'-5"	16'-8"
19.2″	Spruce-Pine-Fir #2	5'-6"	8'-1"	10'-3"	12'-6"	14'-6"
	Douglas Fir-Larch #2	5'-10"	8'-6"	10'-9"	13'-1"	15'-3"
	Hem-Fir #2	5'-10"	8'-6"	10'-9"	13'-1"	15'-3"
24″	Spruce-Pine-Fir #2	4'-11"	7'-3"	9'-2"	11'-2"	13'-0"
	Douglas Fir-Larch #2	5'-2"	7'-7"	9'-7"	11'-9"	13'-7"
	Hem-Fir #2	5'-2"	7'-7"	9'-7"	11'-9"	13'-7"

Elevation-Adjusted Ground Snow Load = 60 psf		Rafter Size				
		2x4	2x6	2x8	2x10	2x12
Rafter Spacing	Species and Grade	Maximum Rafter Spans (ft-in)				
12″	Spruce-Pine-Fir #2	6'-6"	9'-6"	12'-1"	14'-9"	17'-1"
	Douglas Fir-Larch #2	6'-10"	10'-0"	12'-8"	15'-5"	17'-11"
	Hem-Fir #2	6'-10"	10'-0"	12'-8"	15'-5"	17'-11"
16″	Spruce-Pine-Fir #2	5'-8"	8'-3"	10'-5"	12'-9"	14'-10"
	Douglas Fir-Larch #2	5'-11"	8'-8"	10'-11"	13'-4"	15'-6"
	Hem-Fir #2	5'-11"	8'-8"	10'-11"	13'-4"	15'-6"
19.2″	Spruce-Pine-Fir #2	5'-2"	7'-6"	9'-6"	11'-8"	13'-6"
	Douglas Fir-Larch #2	5'-5"	7'-11"	10'-0"	12'-2"	14'-2"
	Hem-Fir #2	5'-5"	7'-11"	10'-0"	12'-2"	14'-2"
24″	Spruce-Pine-Fir #2	4'-7"	6'-9"	8'-6"	10'-5"	12'-1"
	Douglas Fir-Larch #2	4'-10"	7'-1"	8'-11"	10'-11"	12'-8"
	Hem-Fir #2	4'-10"	7'-1"	8'-11"	10'-11"	12'-8"

Elevation-Adjusted Ground Snow Load = 70 psf		Rafter Size				
		2x4	2x6	2x8	2x10	2x12
Rafter Spacing	Species and Grade	Maximum Rafter Spans (ft-in)				
12″	Spruce-Pine-Fir #2	6'-1"	8'-11"	11'-4"	13'-10"	16'-1"
	Douglas Fir-Larch #2	6'-5"	9'-4"	11'-10"	14'-6"	16'-10"
	Hem-Fir #2	6'-5"	9'-4"	11'-10"	14'-6"	16'-10"
16″	Spruce-Pine-Fir #2	5'-4"	7'-9"	9'-10"	12'-0"	13'-11"
	Douglas Fir-Larch #2	5'-7"	8'-1"	10'-3"	12'-7"	14'-7"
	Hem-Fir #2	5'-7"	8'-1"	10'-3"	12'-7"	14'-7"
19.2″	Spruce-Pine-Fir #2	4'-10"	7'-1"	8'-11"	10'-11"	12'-8"
	Douglas Fir-Larch #2	5'-1"	7'-5"	9'-5"	11'-5"	13'-3"
	Hem-Fir #2	5'-1"	7'-5"	9'-5"	11'-5"	13'-3"
24″	Spruce-Pine-Fir #2	4'-4"	6'-4"	8'-0"	9'-9"	11'-4"
	Douglas Fir-Larch #2	4'-6"	6'-7"	8'-5"	10'-3"	11'-11"
	Hem-Fir #2	4'-6"	6'-7"	8'-5"	10'-3"	11'-11"

[1] See footnote 1 on Project Information sheet for the reference document that must be used to determine the elevation-adjusted ground snow load. Round calculated values up to the next highest tabulated value if base ground snow loads are reduced for lower elevations.